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THE PSOLID HOLOTHURIAN GENUS LISSOTHURIA

By DAVID L. PAWSON
Curator, Division of Echinoderms

The holothurians of the family Psolidae are unique in that they have adopted an essentially sedentary mode of existence. The body is more or less flattened and strongly bilaterally symmetrical. While the dorsal surface of the body is generally invested in an armor of imbricating calcareous scales, the ventral surface is a soft thin sole surrounded by tube feet that enable the animal to cling to a hard substrate.

These holothurians may be regarded as "pelmatozoans," while the majority of the other holothurian groups are essentially "eleutherozoan" or free-living. As in other groups of sedentary marine animals, the mouth and anus are on the same side of the body, in this case the dorsal surface, and the gut describes a U-shaped course. Among other echinoderms the U-shaped, pelmatozoan-type gut is found in many Paleozoic groups (including crinoids, blastoids, cystoids, and edrioasteroids); crinoids are the only surviving members of these groups. While the modifications resulting from the adoption by psolids of a sedentary existence show some similarities to those in the extinct edrioasteroids (see Fell, 1965), it is believed that the psolids themselves are not an ancient group of holothurians. Although they are strongly bilaterally symmetrical, their internal anatomy reflects a former radial symmetry, and it seems probable that psolids

arose from an ancestral stock that was radially symmetrical. This topic is discussed briefly elsewhere (Pawson, 1966) and it is hoped that a full discussion will arise from research now in progress.

Gross features of the internal anatomy of psolids are similar to those in other dendrochirotid holothurians; such modifications as are present can be explained readily in terms of the altered shape of the body. The calcareous ring, for example, lies inside the mouth as usual, but, as the mouth is turned dorsally, the calcareous ring is oriented in the anteroposterior plane, so that the posterior edge of the ring is now ventral. Tube feet are very numerous on the ventral surface of the body and restricted to the radii, forming a continuous fringe around the sole. The midventral radius is usually naked in *Psolus* but carries a varying number of feet in other members of the family. Dorsal tube feet are reduced (as in *Psolidium*, *Stolinus*, *Lissothuria*) or absent altogether (as in *Psolus*).

Within the family Psolidae the genus *Psolus* seems to be the most highly modified. Other genera, especially *Psolidium* and *Lissothuria*, show more features in common with other dendrochirotids, and within the genus *Psolidium* it is difficult to determine whether or not some species should be regarded as members of the Psolidae; they might be referred equally well to one or another family elsewhere in the Order Dendrochirotida.

An attempt is being made to revise the entire family Psolidae. The present paper comprises a revision of the small genus *Lissothuria*, which is restricted to the eastern Pacific Ocean and the Caribbean Sea region.

I would like to thank Dr. Willard D. Hartman of the Peabody Museum, Yale University, for many kindnesses, Drs. Bent Hansen and F. Jensenius Madsen of the Zoological Museum, Copehagen, for their help during my visit to that museum in the summer of 1965, and Captain Fred C. Ziesenhenne of the Allan Hancock Foundation, Los Angeles, for facilitating my study of the collections at that institution.

Status of the Genus *Thyonepsolus* Clark

H. L. Clark (1901a, p. 167) described a new holothurian from the coast of California. The species differed from all other psolids known to Clark at that time in possessing calcareous deposits of a unique type on the dorsal surface of the body. In addition to the overlapping scales characteristic of psolids, the dorsal surface carried hourglass-shaped and tower-shaped calcareous deposits. In view of the nature of these deposits, Clark proposed a new genus, *Thyonepsolus nutriens*, to accomodate this species.

In an article on the echinoderms of the Panama region, Verrill (1867, p. 322) had diagnosed and described *Lissothuria ornata* on the basis of one specimen collected from Panama. Verrill's description was inadequate in some respects, and subsequent authors generally regarded *Lissothuria* as a synonym of *Psolus*, noting that the species required reexamination. Deichmann (1937, p. 172), in describing the new species *Thyonepsolus beebei* from Lower California, suggested that "Verrill's imperfectly described *Lissothuria ornata* (1867) from Panama may quite well be this species."

I have reexamined the type-specimen of *Lissothuria ornata*. The deposits of the dorsal surface of the body of this specimen include hourglass-shaped deposits and towers, which are diagnostic characters of *Thyonepsolus*. In the Zoological Museum, Copenhagen, six other specimens of *L. ornata* from Panama were found. All of this material is described below. It is evident that *Thyonepsolus* is a junior synonym of *Lissothuria*, and it is here proposed that the generic name *Lissothuria* be resurrected as a senior synonym.

Lissothuria Verrill

Lissothuria Verrill, 1867, p. 322.
Thyonepsolus H. L. Clark, 1901a, p. 167. [Type-species: *T. nutriens*, original designation.]
Thionepsolus Delage and Herouard 1903, p. 320. [Error for *Thyonepsolus*.]

DIAGNOSIS.—Psolids with tube feet on dorsal surface of body and in midventral interradius. Dorsal scales few or numerous, imbricating, covered by an external layer of deposits that include hourglass-shaped bodies and towers; one of these types may be absent. Sole deposits are knobbed or smooth plates; in some species shallow or deep cups also present.

TYPE-SPECIES.—*Lissothuria ornata* Verrill (original designation, by monotypy).

CONTENT OF GENUS.—Verrill (1867) described *Lissothuria ornata*. In 1901, H. L. Clark described *Thyonepsolus nutriens*. Deichmann (1930) referred Theel's (1886) species *Psolus braziliensis* to *Thyonepsolus* and later (Deichmann, 1937) described a new species, *T. beebei*, from the Gulf of California. Again, Deichmann (1941) described two other new species, *T. veleronis* from the Galapagos Islands and *T. hancocki* from Lower California. Thus, at the commencement of this study, six species had been named. In this paper, two of the original six species (*Lissothuria ornata* and *Thyonepsolus beebei*) are regarded as synonyms and three species are described as new, so that eight species may now be listed under the genus *Lissothuria*.

Key to Species of Genus *Lissothuria*

1. Dorsal scale covering incomplete . . . . . **nutriens** (Clark)
   Dorsal scale covering complete 2
2. Rosettes present in tentacles 3
   Rosettes absent from tentacles 5
3. Sole deposits include cups; plates in sole knobbed . . **antillensis,** new species
   Sole deposits plates only; plates smooth or with inconspicuous knobs . . 4
4. Hourglass-shaped deposits closely resemble cups; average height of towers 0.1 mm. Caribbean . . . . . **braziliensis** (Theel)
   Hourglass-shaped deposits of "typical" form; average height of towers 0.27 mm. Eastern Pacific . . . . . **ornata** Verrill
5. Deposits in sole include strongly knobbed plates that tend to become 2-layered **deichmannae,** new species
   No such plates in sole 6
6. Sole deposits include cups; hourglass deposits absent. **mortenseni,** new species
   Cups absent from sole; hourglass deposits present 7
7. Towers absent; 7–8 scales between oral and anal apertures. **veleronis** (Deichmann)
   Towers present; ca. 14 scales between oral and anal apertures. **hancocki** (Deichmann)

DISTRIBUTION.—The eight known species in the genus resemble each other in so many respects that it seems likely that the genus is a relatively young one, arising (perhaps from some *Psolidium*-like ancestor) in the Caribbean or Eastern Pacific and dispersing across the Isthmus of Panama when it was below sea level, perhaps during the early Tertiary. At the present time, six species are known from the Eastern Pacific and two from the Caribbean region. This suggests that the migration was from west to east. The distribution of this genus is paralleled by other genera in the Holothuroidea, and it is known that at least 10 species of holothurians are common to the Pacific and Atlantic sides of the Isthmus of Panama.

Lissothuria ornata Verrill

FIGURES 1, 2F–L

Lissothuria ornata Verrill, 1867, p. 322.
Psolus ornatus.—Theel, 1886a, p. 127.—Ludwig, 1892, p. 350.
Thyonepsolus beebei Deichmann, 1937, p. 172, fig. 3; 1938, p. 382; 1941, p. 139, pl. 28 (figs. 1–3).

DIAGNOSIS.—Dorsal scale covering complete. Deposits of dorsal surface are perforated plates, towers, and hourglass-shaped deposits; no cups. Deposits of sole are perforated plates, which are smooth or with a few rounded knobs. Tentacles with rosettes.

DESCRIPTION OF HOLOTYPE.—Specimen cut transversely at middle of body. Total length 51 mm, greatest breadth 18 mm, height at center 10 mm. Mouth anterodorsal, anal aperture posterodorsal. Oral aperture surrounded by numerous irregular valves with

sharp points on free edges. Arrangement of valves indeterminable. Dorsal surface completely covered by imbricating scales, through and between which pass inconspicuous tube feet. Finely papillate integument containing calcareous deposits overlies scales. Sole elongate, oval, fringed by 5–6 rows of closely crowded tube feet, which form a continuous margin. Midventral radius with 3–5 rows of tube feet throughout. Sole leathery, opaque. Tentacles richly branched. Color in alcohol yellowish white overall.

Calcareous deposits of dorsal surface (apart from scales) are towers, hourglass-shaped deposits, and some flat plates. Towers complex, height ranging from 0.25 to 0.40 mm, diameter at base 0.15 to 0.20 mm. Tops of towers irregular, not carrying distinct teeth (fig. 1F). Hourglass deposits fragile, with numerous perforations, varying greatly in size and shape; length ranges from 0.08 to 0.15 mm (fig. 1B). Flat plates with larger central perforations and smaller marginal perforations present; diameter ranges from 0.05 to 0.3 mm (figs. 1D,E). Plates fragile, often broken.

Sole with flat perforated plates of varying shape (fig. 1C), greatest length 0.17 to 0.22 mm. Margins of plates smoothly indented; some plates with low rounded knobs.

Tentacles with minute rosettes that vary greatly in size and degree of complexity (fig. 1G), also curved or flat perforated plates and rods (fig. 1A). Tube feet with end plates; feet supported by narrow perforated rods of average length 0.19 mm (fig. 1H).

Color.—Verrill (1867, p. 322) noted that the color in alcohol of this specimen was "light purple, whitish beneath, disk [sole] purple, with a yellowish white ring around the mouth; tentacles purple at base, the subdivisions yellowish." At the time Verrill described the specimen, it had been in alcohol for less than six months, and thus apparently the color had faded very little. No trace of this striking original coloration now can be found.

Holotype.—Peabody Museum of Natural History, Yale University, YPM no. 5327.

Type-locality.—Pearl Island Panama; collected by F. H. Bradley, December 1866.

Additional material.—A collection of six specimens from Taboga, Panama, was examined in the Zoological Museum, Copenhagen. Some information on the internal anatomy of the species is given below.

Total length 27–37 mm. Midventral radius with 3–5 rows of tube feet anteriorly and posteriorly, but at center of radius rows, without exception, double. Dorsal surface of body with 8–10 scales between oral and anal apertures. Mesentery of posterior loop of intestine lies in left ventral interradius. Gonad a large mass of long unbranched cacea. A single bulbous Polian vesicle; respiratory

trees flattened tubes with long simple branches. Ventral retractor muscles smaller than dorsal muscles (perhaps an artifact of preservation). Calcareous ring simple, interradial pieces bluntly pointed anteriorly, radial pieces notched anteriorly for attachment of radial muscles. Posterior margin of calcareous ring undulating, lacking projections.

In smaller specimens towers not nearly as well developed as in holotype (fig. 2K); deposits in sole tend to have a more regularly indented margin (fig. 2F).

REMARKS.—*Lissothuria beebei* (Deichmann) is regarded here as a synonym of *L. ornata*. No significant differences between these species can be found; in her original description of *L. beebei*, Deichmann (1937, p. 174) called attention to the possibility that the species were synonymous (see above). *L. ornata* may be distinguished readily from other Eastern Pacific species since it is the only species that possesses rosettes in the tentacles.

DISTRIBUTION.—The species has been recorded from the following localities: Pearl Island, Gulf of Panama (type-locality; Verrill, 1867, p. 322); Taboga, Panama, coast under stones at low water, collected by Th. Mortensen, Nov. 7, 1915; off Arena Bank, 23°26′ N, 109°24′30″ W, 2.5 fathoms, in *Pocillopora ligulata* (type-locality of *L. beebei;* Deichmann, 1937, p. 173); Tangola-Tangola, Mexico, 15°46′ N, 96°06′ W, 15–20 fathoms (Deichmann, 1941, p. 140); Thurloe Bay, west coast of Lower California, 8–10 fathoms (Deichmann, 1941, p. 140); Situatanejo Bay, Mexico, 17°37′ N, 101°34′ W, shore (Deichmann, 1938, p. 382); Jasper Island, Gulf of Nicoya, Costa Rica, 9°46′ N, 84°54′ W, shore (Deichmann, 1938, p. 382). The species thus ranges from Lower California to Panama in depths of 0–36 meters and has been found on two occasions in association with corals.

Lissothuria nutriens (Clark)

Thyonepsolus nutriens H. L. Clark, 1901a, p. 169, figs. 6–14; 1901b, p. 491; 1923, p. 161.—Deichmann, 1937, p. 174; 1941, p. 138, pl. 26 (figs. 1–5).

DIAGNOSIS.—Dorsal scale covering incomplete. Deposits of dorsal surface are towers and hourglass-shaped deposits; no cups. Deposits of sole are perforated plates with raised marginal projections and small cups. Tentacles lack rosettes.

MATERIAL EXAMINED.—Allan Hancock Foundation: Velero Sta. 1447–42, Point Arguello Boat Station, outside of breakwater, among loose rock in tide pools, collected Mar. 13, 1942, by F. C. Ziesenhenne, 1 specimen; Velero Sta. 1575–46, 6.7 miles south of surf, Pedernales Point, Santa Barbara Co., Calif., intertidal, Dec. 7, 1946, 1 specimen; Velero Sta. 1576–46, 0.5 mile north of Cayucos, San Luis Obispo Co., Calif., intertidal, Dec. 8, 1946, 1 specimen.

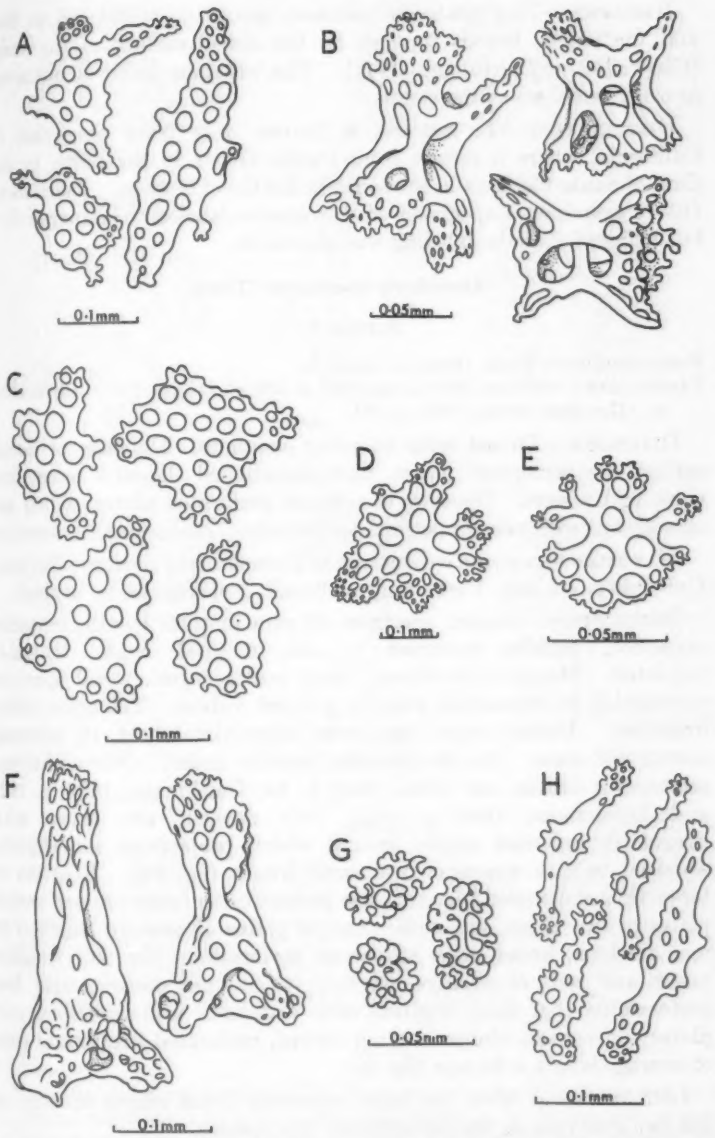

FIGURE 1.—*Lissothuria ornata* Verrill, holotype: A, plates from tentacles; B, hourglass-shaped deposits from dorsal body wall; C, perforated plates from sole; D, portion of larger plate from dorsal body wall; E, smaller plate from dorsal body wall; F, towers from dorsal body wall; G, rosettes from tentacle; H, deposits from tube feet.

REMARKS.—This relatively common species is bright red in life, and the female broods its eggs on the dorsal surface of the body (Clark, 1901a; Deichmann, 1941). The brooding habit is unknown in other members of the genus.

DISTRIBUTION.—*L. nutriens* is known only from the coast of California, where it ranges from Pacific Grove in the north to the Gulf of Santa Catalina in the south in depths of 0–20 m. Deichmann (1941) examined a specimen of this species labeled "Galapagos Is." but believed that the labeling was erroneous.

Lissothuria braziliensis (Theel)

FIGURES 2A–E

Psolus braziliensis Theel, 1886b, p. 15, fig. 7.
Thyonepsolus braziliensis Deichmann, 1930, p. 192, pl. 21 (figs. 1–6).—Clark, 1933, p. 117.—Deichmann, 1954, p. 401.

DIAGNOSIS.—Dorsal scale covering complete. Deposits of dorsal surface are perforated plates, hourglass-shaped deposits resembling cups, and towers. Deposits of sole are perforated plates, which are smooth but with raised marginal projections. Tentacles with rosettes.

MATERIAL EXAMINED.—Museum of Comparative Zoology, Harvard University, no. 348, Porto Seguro, Brazil, 2 specimens (syntypes).

DESCRIPTION.—Larger specimen 32 mm in total length, tentacles expanded. Smaller specimen 14 mm in total length, tentacles retracted. Mouth anterodorsal, anus posterodorsal. Oral aperture surrounded by numerous sharply pointed valves. Tentacles richly branched. Dorsal scales numerous, approximately 8–10 between mouth and anus. No obvious skin overlies scales. (For additional anatomical details, see Theel, 1886, p. 15; Deichmann, 1930, p. 192; and Deichmann, 1954, p. 401.) Sole deposits are plates with irregularly indented edges, around which projections are slightly upraised to give appearance of small knobs (fig. 2B). Rosettes in tentacles not complex (fig. 2E); also present in tentacles are perforated plates of two types, and rods. Larger plates of average length 0.47 mm are long, broad, with numerous perforations (fig. 2C); smaller plates and rods of average length 0.16 mm are narrow, with few perforations (fig. 2D). Ventral tube feet have well-developed end plates and contain elongate, often curved, perforated supporting rods of average length 0.18 mm (fig. 2A).

LECTOTYPE.—I select the larger specimen (total length 32 mm) of the two syntypes as the lectotype of this species.

REMARKS.—In possessing rosettes in the tentacles, *L. braziliensis* falls close to *L. antillensis*, new species (see below), but it differs from that species in lacking cups in the sole.

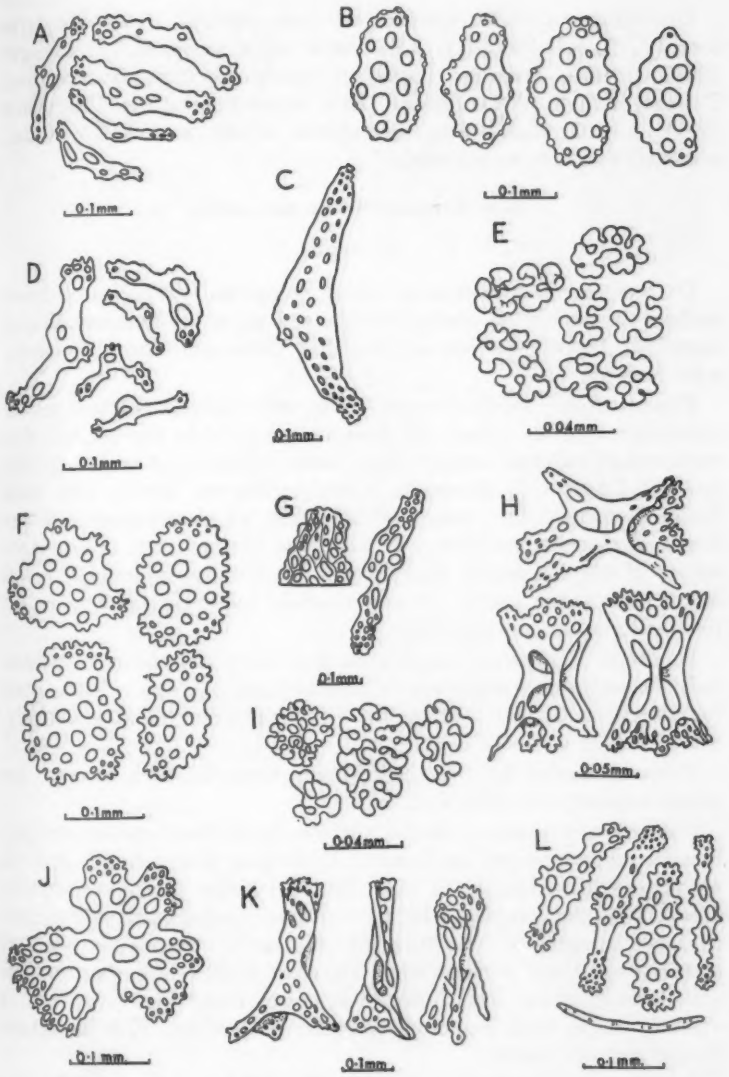

FIGURE 2.—*Lissothuria braziliensis* (Theel), paratype: A, deposits from tube feet; B, perforated plates from sole; C, larger plate from tentacle; D, smaller rods and plates from tentacle; E, rosettes from tentacle. *L. ornata* Verrill, paratype: F, perforated plates from sole; G, plates from tentacle; H, hourglass-shaped deposits from dorsal body wall; I, rosettes from tentacle; J, plate from dorsal body wall; K, towers from dorsal body wall; L, deposits from tube feet.

DISTRIBUTION.—The species has been reported from the type-locality (Theel, 1886b, p. 15), Porto Seguro, Brazil. Deichmann (1930, p. 193) recorded numerous specimens from Buccoo Bay, Tobago, British West Indies. In a later publication Deichmann (1954, p. 401) noted that this species occurs in "shallow water, attached to rocks or seaweeds."

Lissothuria antillensis, new species

FIGURE 3

DIAGNOSIS.—Dorsal scale covering complete. Deposits of dorsal surface are perforated plates, towers, and cups; no hourglass-shaped deposits. Deposits of sole are knobbed plates and cups. Tentacles with rosettes.

DESCRIPTION.—Body elongate, about twice as long as broad, mouth anterodorsal, anus dorsal. Dorsal surface of body arched, sole flat, rectangular. Dorsal surface with thick imbricating scales approximately 1.5 mm in diameter; 7 scales between mouth and anus. Scales perforated for passage of tube feet, which are scattered over dorsal surface; sometimes 4–5 feet pass through one scale. Oral valves of varying shape, sharply pointed distally, interradial valves larger than radial valves. Scales overlaid by thick soft integument filled with calcareous deposits.

Sole with 2–3 rows of larger tube feet along left and right ventral radii (in addition to single row of smaller marginal feet). Midventral radius with tube feet throughout, 3 rows anteriorly and posteriorly, 1–2 rows near center of sole.

Color in alcohol light to dark brown; tentacles dark brown. Internal anatomy not examined.

Calcareous deposits of dorsal surface (apart from scales) are perforated plates, towers, and cups. Perforated plates small, smooth, average greatest length 0.1 mm (fig. 3E); larger plates occasionally found. Towers complex, with dentate apex; average height 0.18 mm, average diameter of base 0.15 mm (fig. 3G). Deep cups (fig. 3A) common on dorsal surface; cups typically with 4 large perforations and 4 conspicuous knobs projecting from underside. Cup rim of variable shape, with numerous irregular projections. No hourglass-shaped deposits found.

Sole deposits are plates and cups. Plates 0.1 to 0.12 mm in length, oval to rectangular, perforated, with low rounded knobs around margin and in center (fig. 3B). Cups of average diameter 0.074 mm, shallow, resembling buttons, with 4 larger perforations and some scattered smaller perforations; margin and center of each cup with low rounded projections (fig. 3F).

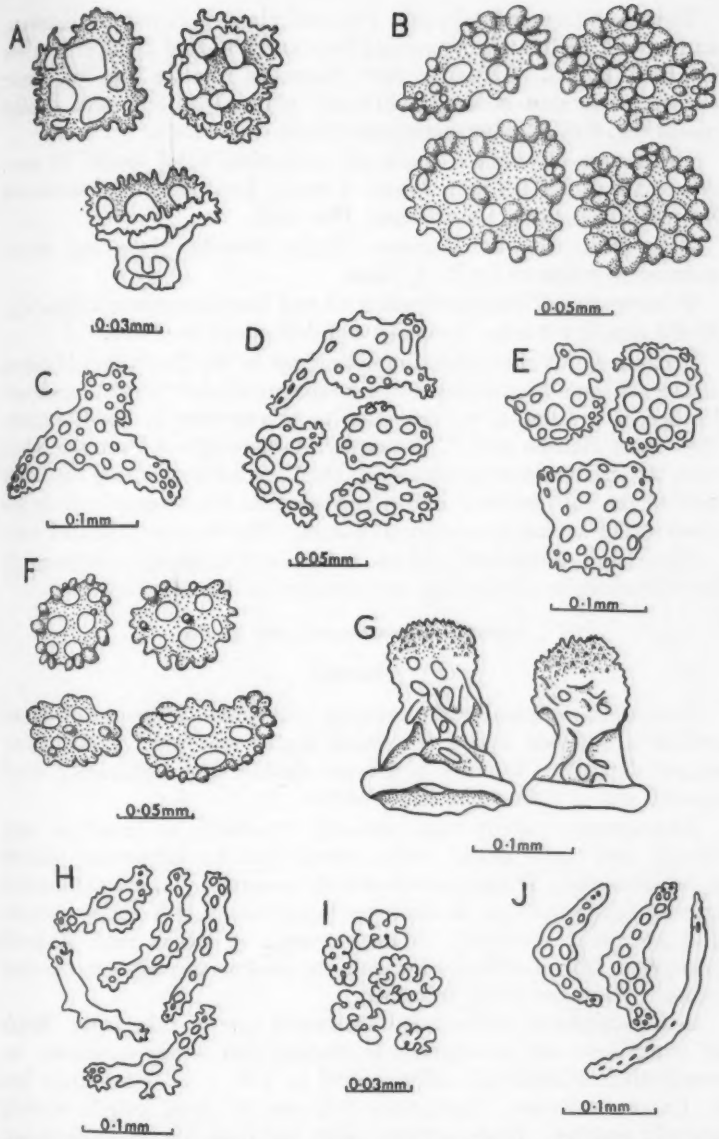

FIGURE 3.—*Lissothuria antillensis*, new species: A, cups from dorsal body wall; B, perforated plates from sole; C, rare larger plate from tentacle; D, small plates from tentacle; E, plates from dorsal body wall; F, cups from sole; G, towers from dorsal body wall; H, deposits from ventral tube feet; I, rosettes from tentacle; J, curved perforated rods from tentacle.

Dorsal and ventral tube feet with end plates 0.21 mm in diameter, and curved perforated supporting rods and plates of average greatest length 0.15 mm. Tentacles with numerous rosettes (fig. 3I), larger curved perforated rods (fig. 3J) and plates (fig. 3C), and smaller plates (fig. 3D). Larger perforated plates uncommon.

HOLOTYPE.—Complete specimen, expanded, total length 10 mm, greatest breadth 4.5 mm, height 4 mm. Lodged at Universitetets Zoologiske Museum, Copenhagen, Denmark.

TYPE-LOCALITY.—St. Thomas, Virgin Islands (date and depth unknown); collected by A. A. Riise.

PARATYPES.—Three specimens 9 x 5 mm (length x greatest breadth), 12 x 5 mm, 9 x 4 mm. Locality and depository as above.

REMARKS.—While examining collections in the Zoological Museum at Copenhagen, I found the above specimens labeled "*Psolus antillensis* Lütken." I know of no reference to this species in the literature. Drs. Bent Hansen and F. Jensenius Madsen agreed that the labels with the specimens were written by Dr. C. F. Lütken during the latter part of the 19th century, and it appears that *Psolus antillensis* is one of several of Lütken's manuscript names. The name is validated here.

Lissothuria antillensis differs from its Caribbean congener *L. braziliensis* in having shallow cups among the deposits of the sole.

Lissothuria mortenseni, new species

FIGURE 4

DIAGNOSIS.—Dorsal scale covering complete. Deposits of dorsal surface are towers and a few small plates; no cups, no hourglass-shaped deposits. Deposits of sole are shallow cups and, rarely, small smooth plates. Tentacles lack rosettes.

DESCRIPTION.—Body approximately two-thirds as broad as long. Mouth and anus dorsal, each surrounded by numerous sharply pointed valves. Dorsal surface of body covered by imbricating scales approximately 1.5 mm in diameter; approximately 6 scales between oral and anal apertures. Scales covered by dense coat of small granules. Dorsal tube feet few, minute, passing through and between scales. Tentacles richly branched.

Sole transparent, surrounded by double row of tube feet. Single or triple rows not uncommon in smaller and larger specimens respectively. Midventral radius naked or with 1 or a few tube feet in larger specimens. Specimens 8–9 mm in total length already sexually mature. Sexes separate, eggs less than 0.5 mm in diameter.

Calcareous deposits of dorsal surface (apart from scales) are almost exclusively towers of approximately same size and shape; average height 0.13 mm, average diameter of base 0.13 mm (figs. 4A,B).

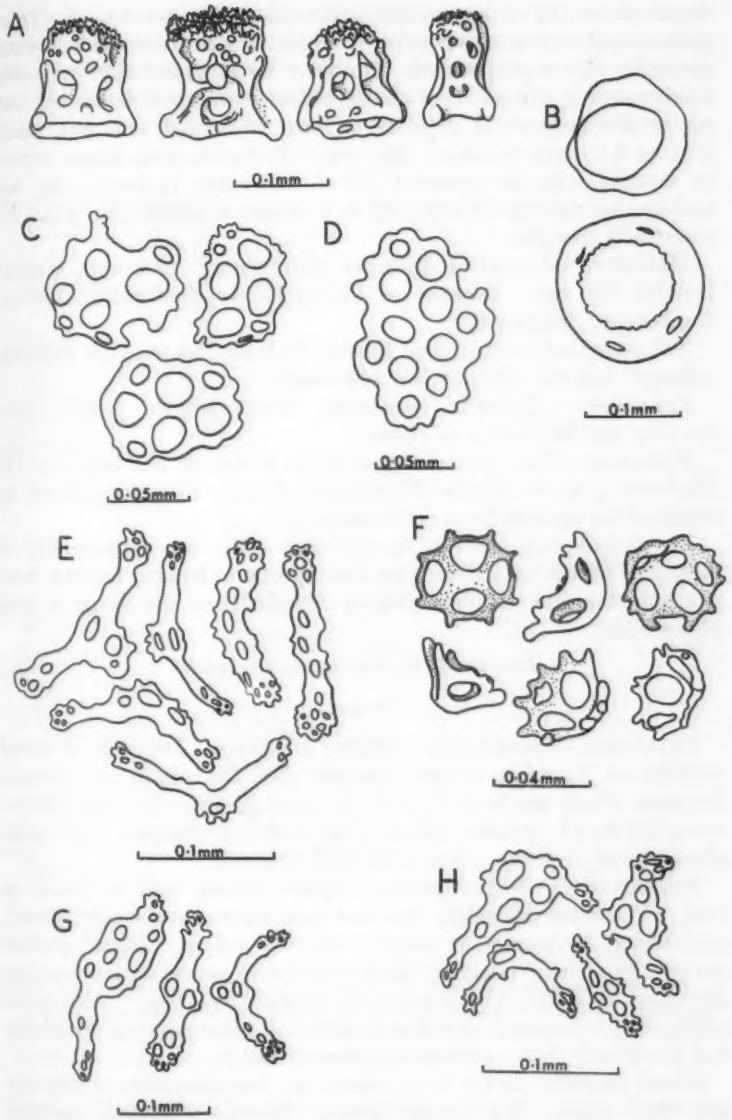

FIGURE 4.—*Lissothuria mortenseni*, new species: A, towers from dorsal body wall; B, basal view of towers (partly diagrammatic); C, rare plates from dorsal body wall; D, rare plate from sole; E, deposits from tube feet; F, cups from sole; G, larger deposits from tentacle; H, smaller deposits from tentacle.

Small plates (fig. 4C) sparingly scattered among towers. No hourglass-shaped deposits; no cups. Sole with numerous shallow cups, typically with 4 perforations (fig. 4F). Small plates (fig. 4D) occur rarely among cups. Ventral tube feet with well-developed end plates and supporting deposits in form of curved rods and plates 0.11 to 0.15 mm in length (fig. 4E). Tentacles with larger curved or straight rods and plates 0.130 to 0.225 mm in length (fig. 4G) and smaller rods and plates 0.08 to 0.13 mm in length (fig. 4H). No rosettes in tentacles.

HOLOTYPE.—Complete specimen, total length 12.5 mm, greatest breadth 9.8 mm. Located at Universitetets Zoologiske Museum, Copenhagen, Denmark.

TYPE-LOCALITY.—San Jose Island, Gulf of Panama, 25 fathoms, collected Jan. 27, 1916, by Th. Mortensen.

PARATYPES.—Thirteen specimens, total length 8–14.5 mm. Locality and depository as above.

REMARKS.—This species is named in honor of the late Dr. Th. Mortensen, whose Pacific Expedition of 1914–1916 contributed so much to our knowledge of echinoderms.

Lissothuria mortenseni is known from near the type-locality of *L. ornata* Verrill but differs from that species in lacking rosettes from the tentacles and hourglass-shaped deposits from the dorsal surface of the body.

Lissothuria deichmannae, new species

FIGURE 5

DIAGNOSIS.—Dorsal scale covering complete. Deposits of dorsal surface are hourglass-shaped deposits and flat plates; no towers. Deposits of sole are larger heavily knobbed plates, which tend to become 2-layered, smaller plates with knobbed margins, and hourglass-shaped deposits. Tentacles lack rosettes.

DESCRIPTION.—Single specimen approximately half as broad as long. Tentacles expanded, oral and anal apertures dorsally placed, surrounded by numerous sharply pointed valves. Dorsal surface covered by scales overlaid by thick integument packed with calcareous deposits. Sole thin, with 2–3 rows of marginal tube feet. Midventral radius with 1–2 rows of tube feet throughout, more crowded anteriorly and posteriorly, but scattered at center of radius.

Dorsal deposits (apart from scales) are hourglass-shaped deposits and flat plates. No towers found. Hourglass-shaped deposits variable in shape and size (fig. 5A), length ranging from 0.05 to 0.1 mm. Some resemble cups with ventral projections; others are asymmetrical. Flat plates of 0.18 mm average greatest length, with larger perforations near center (fig. 5E); some plates may occur in dorsal tube feet.

Sole deposits are large plates with conspicuous knobs, which become multilayered with growth (fig. 5F); plates approximately circular, massive, of average diameter 0.14 mm. Smaller plates with indented, knobbed margins and occasionally small knobs elsewhere also present; plates with few large perforations, generally 4 central perforations

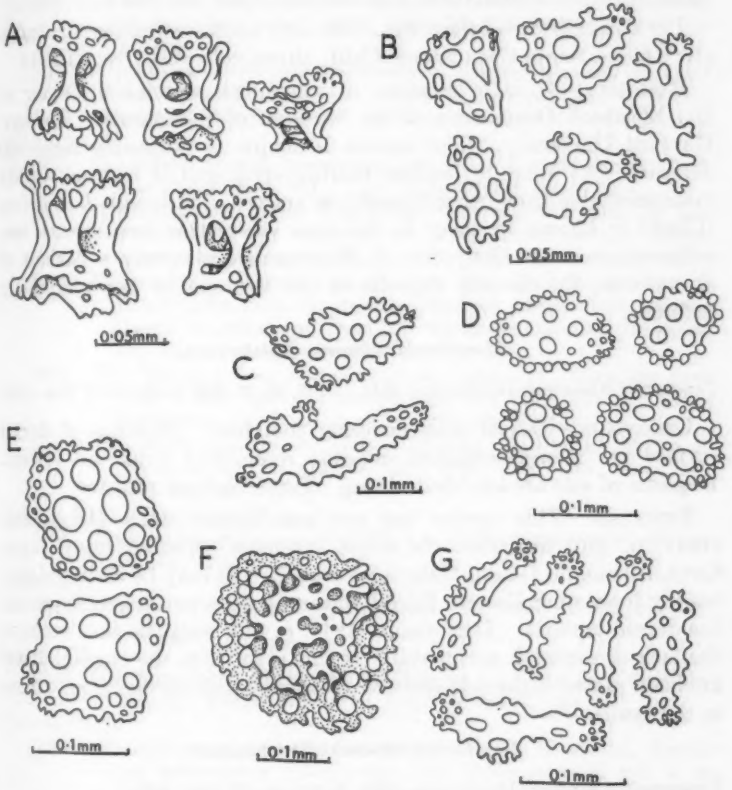

FIGURE 5.—*Lissothuria deichmannae*, new species: A, hourglass-shaped deposits from dorsal body wall; B, smaller rods and plates from tentacles; C, larger plates from tentacles; D, smaller knobbed plates from sole; E, plates from dorsal body wall; F, larger 2-layered knobbed plate from sole; G, deposits from ventral tube feet.

larger. Average length of small plates 0.1 mm (fig. 5D). Overlying plates are small numbers of hourglass-shaped deposits similar to those of dorsal surface, but even more variable in shape.

Tentacle stems and digits with larger plates up to 0.30 mm in length (fig. 5C) and smaller rods and plates up to 0.1 mm in length

(fig. 5B). Ventral tube feet with well-developed end plate and curved, perforated supporting rods and plates of average length 0.14 mm (fig. 5G).

HOLOTYPE.—Complete specimen, total length 10.5 mm, greatest breadth 4.5 mm, height 3.0 mm. Located in the collection of the Allan Hancock Foundation, Los Angeles, AHF no. 325.1.

TYPE-LOCALITY.—Velero Sta. 1660–48, southwest shore of Smuggler's Cove, Santa Cruz Island, Calif., shore, collected Dec. 29,1948.

REMARKS.—It is a pleasure to name this species in honor of Dr. Elisabeth Deichmann of the Museum of Comparative Zoology, Harvard University. This species is unique in possessing large sole deposits that tend to become multilayered, and it is thus readily distinguishable from other *Lissothuria* species. Although *L. nutriens* (Clark) is known to occur in the area where this new species was collected, it is not likely that *L. deichmannae* is merely a variant of *L. nutriens*, for the sole deposits of the two species are completely different.

Lissothuria veleronis (Deichmann)

Thyonepsolus veleronis Deichmann, 1941, p. 140, pl. 26 (figs. 6–8), pl. 27 (figs. 8–9).

DIAGNOSIS.—Dorsal scale covering complete. Deposits of dorsal surface are hourglass-shaped deposits resembling cups; no towers. Deposits of sole are knobbed plates. Tentacles lack rosettes.

REMARKS.—This species has not been found since Deichmann (1941, p. 140) described the single specimen collected from Tagus Cove, Albemarle Island, Galapagos Islands. It may be distinguished readily from other Eastern Pacific species since no towers occur among the dorsal deposits. Deichmann (1941, p. 140) suggests that perhaps the lack of towers is accidental. If this is so, then the characteristic knobbed plates of the sole serve to distinguish this species from others in the genus.

Lissothuria hancocki (Deichmann)

Thyonepsolus hancocki Deichmann, 1941, p. 140, pl. 27 (figs. 1–7).

DIAGNOSIS.—Dorsal scale covering complete. Deposits of dorsal surface are hourglass-shaped deposits and towers. Deposits of sole are knobbed plates. Tentacles lack rosettes.

REMARKS.—As with the above species, no further material of *L. hancocki* has been reported in the literature. Deichmann (1941, p. 141) described this species on the basis of a series of 49 specimens collected in the Gulf of California and off the coast of Ecuador in depths of 5–165 fathoms.

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